Short Communications

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Comparison of Fledging Success and Sizes of Prey Consumed by Spotted Owls in Northwestern California

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Several studies have documented the food habits of spotted owls (*Strix occidentalis;* Forsman 1980, Solis 1983, Forsman et al. 1984, Barrows 1980, 1985, 1987, Thrailkill and Bias 1989, Ward 1990). Only a few studies have investigated the relationship between size of prey consumed and reproductive success (Barrows 1987, Thrailkill and Bias 1989, Ward 1990), but successful breeding has been associated with a greater proportion of large mammalian prey items (>100 g) within the diet of both northern (*S. o. caurina*) and California (*S. o. occidentalis*) subspecies of the spotted owl (Barrows 1987, Thrailkill and Bias 1989). Despite this, Ward (1990) found no significant difference in prey sizes of breeding and nonbreeding owls in northwestern California.

Optimal foraging theory predicts that predators consume prey providing the greatest energetic benefit-to-cost ratio (Krebs 1978). More specifically, central place foragers, such as breeding spotted owls, are expected to increase fitness by maximizing rate of energy delivery to the central place, or nest (Orians and Pearson 1979). Thus, consumption of large prey would be expected to yield a greater energetic return than consumption of small prey (assuming costs of capturing large prey is not disproportionate to costs required for small prey capture). As a result, a positive association is expected between prey size (an index of energetic gain) and fledging success (an index of fitness). Theoretically, selection of larger prey should provide parents with an energetic surplus enabling them to meet the increased energy demands associated with producing young. This study was undertaken to determine if the food consumption of breeding northern spotted owls is consistent with the predictions of optimal foraging theory. Proximate explanations, such as prey availability and individual hunting behavior, which may account for observed patterns in prey consumption and reproductive success, are difficult to assess and were beyond the scope of this study.

Breeding spotted owls were located using standard survey techniques (Forsman 1983) in a 292 km^2 study area located south of Willow Creek, Humboldt County, California, and in 12 satellite areas located in Mendocino, Humboldt, Trinity, and Siskiyou counties, California (see Franklin et al. 1996 for description of the study area). Both study areas were dominated by mixed evergreen forest and Klamath montane forest vegetation types (Küchler 1977).

Owl pairs were considered successful if they fledged young and unsuccessful if no young fledged. Pellets were collected opportunistically at owl roost sites. Prey were identified and counted from skulls or reconstructed appendicular skeletons, whichever gave the highest count (Forsman et al. 1984). Mean weight of individual prey species was based on Forsman (1980), Solis (1983), and the Humboldt State University reference collection. Prey items were divided into three size classes, based on natural breaks in the sizes of prey taken by northern spotted owls: large prey >269 g, medium prey 80–115 g, and small prey <35 g. Frequency and biomass of each prey type were calculated for successful and unsuccessful pairs of breeding owls and Chi-square analysis was used to compare frequencies of prey size categories in their diets (Ott 1988). Contingency table subdivision was used to isolate significance (Zar 1974).

A total of 672 prey items were identified from 330 pellets collected in 63 known owl territories from April through August 1987–95. Of the total prey items, 418 were collected from territories of successfully breeding owls and 254 were from territories where owls failed to fledge young.

Large prey accounted for the largest proportion of prey biomass eaten by both successful (0.72) and unsuccessful breeding owl pairs (0.55), as well as the highest proportion (0.36) of individual food items taken by successfully breeding pairs (Table 1). Small prey accounted for the highest proportion (0.41) of food items eaten by unsuccessfully breeding owls.

The diet of owls that successfully fledged young dif-

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Table 1. Proportion of prey based on frequency and biomass in the diets of spotted owls relative to fledging success in northwestern California from 1987–95.

	SUCCESSFUL		UNSUCCESSFUL	
SPECIES	FREQUENCY ($N = 418$)	BIOMASS (g) ($N = 54{,}362$)	FREQUENCY ($N = 254$)	BIOMASS (g) ($N = 26{,}980$)
Large prey (>269 g)				
Neotoma fuscipes	0.34	0.72	0.22	0.55
Unidentified large prey	0.02	N/A	0.01	N/A
Subtotal	0.36	0.72	0.23	0.55
Medium prey (80–115 g)				
Glaucomys sabrinus	0.26	0.24	0.35	0.38
Eutamias sp.	0.01	0.01	0.00	0.00
Sylvilagus bachmani (juv.)	<0.01	<0.01	0.00	0.00
Unidentified medium prey	0.01	0.01	0.01	0.01
Subtotal	0.28	0.25	0.36	0.38
Small prey (<35 g)				
Arborimus longicaudus	0.08	0.02	0.15	0.04
Clethrionomys californicus	0.02	<0.01	0.05	0.01
Peromyscus sp.	0.11	0.02	0.07	0.02
Microtus sp.	0.01	<0.01	0.02	<0.01
Scapanus sp.	<0.01	<0.01	0.00	0.00
Sorex sp.	<0.01	<0.01	<0.01	<0.01
Lasionycteris noctivagans	<0.01	<0.01	0.00	0.00
Reithrodontomys megalotis	0.02	<0.01	0.01	<0.01
Unidentified small prey	0.04	N/A	0.03	N/A
Unidentified small bird	0.03	N/A	0.03	N/A
Unidentified insect	0.03	N/A	0.04	N/A
Subtotal	0.35	0.04	0.41	0.07
Total	1.00	1.00	1.00	1.00

fered significantly in terms of prey size from the diet of owls that failed to fledged young ($\chi^2 = 14.78$, df = 2, $P < 0.001$). No significant difference was detected between successful and unsuccessful owls relative to the number of medium and small prey found in pellets ($\chi^2 = 0.47$, df = 1, $P = 0.49$). However, a significant difference was detected when comparing successful and unsuccessful owls relative to large and pooled medium/small prey ($\chi^2 = 14.28$, df = 1, $P < 0.001$).

My analysis indicated that spotted owls which successfully fledged young ate significantly more large prey items than unsuccessful owls. Spotted owls consumed about 40 g of food per feeding period so large prey items appeared to provide owls with a large (239 g), efficiently transported food source with each prey capture. Unsuccessfully breeding owls consumed more medium and small prey than large. Transportation of prey back to a central place, such as a nest, places increased energetic demands on a predator (Orians and Pearson 1979). Thus, capture of medium and small prey may result in an energetic trade-off due to decreased energetic returns. Ultimately, this would cause spotted owls to suspend breeding in a given year if food fell below levels necessary to maintain adult energy requirements (Alcock 1993).

Bull et al. (1989) found that male great gray owls (*Strix nebulosa*) maximized the return for their hunting energy expenditure by eating smaller prey at the point of capture and taking larger prey back to the nest. Such preferential prey delivery to nests can bias results of dietary studies. I do not consider this to have been the case in my study because pellets collected at roosts contained remains of all prey captured throughout the nocturnal hunting period.

My results support optimal foraging and central place foraging theories as ultimate explanations for the observed positive relationship between large prey size and fledging success. Future investigations of proximate explanations for their tendency to hunt larger prey will contribute to our understanding of the influence of prey size on spotted owl fledging success.

RESUMEN.—Las dietas de *Strix occidentalis* fueron comparadas en relación al éxito de volantones, investigando el tamaño de las presas (grande, >269 g; mediana 80–115 g; pequeña, <35 g) encontradas en 330 pelletts colectados en 63 territorios de búhos en el noroeste de California. Seiscientos setenta y dos categorías de presas fueron identificadas. Las egagrópilas colectadas en territorios de búhos con juveniles exitosos contenían significativamente una mayor proporción de presas grandes que las egagrópilas de parejas sin volantones exitosos. Las dietas de búhos reproductivos exitosos y no exitosos no tenían diferencias significativas relacionadas con la frecuencia de presas medianas y pequeñas. Esta relación es consistente con otros estudios de *S. occidentalis* y podría estar relacionado al alto contenido de enregía de grandes presas.

[Traducción de Ivan Lazo]

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